TEXTILE RESEARCH

Publication of

United States Institute for Textile Research, Inc.

CHARLES H. CLARK, *Managing Editor,*

Publication Office: Prince and Lemon Sts., Lancaster, Pa.

Editorial and General Offices: 65 Franklin St., Boston, Mass.

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Vol. X **August, 1940** **No. 10**

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Entered as second-class matter, November 17, 1932, at the Post Office at Lancaster, Pa., under the Act of Congress of March 3, 1879.

Issued monthly at Prince and Lemon Streets, Lancaster, Pa., for United States Institute for Textile Research, Inc., Boston, Mass.

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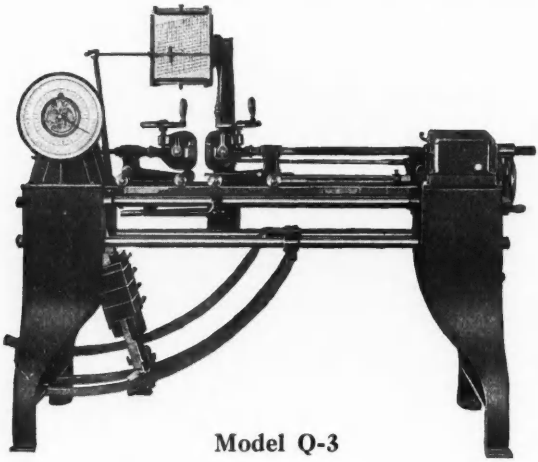

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TEXTILE RESEARCH

Publication of

United States Institute for Textile Research, Inc.
and for the Released Research Reports of
The Textile Foundation, Inc.

"Textile Inventory Policies and Statistical Guides"

ACCORDING to the report of Fessenden S. Blanchard, chairman of the Institute's Committee on Economic Research, it is expected that the study of "Textile Inventory Policies and Statistical Guides" will be completed by the end of the year. This research was recommended by this committee and it is being conducted, with their co-operation and that of an Advisory Committee of the Textile Foundation, by the Industrial Research Department of the Wharton School of Finance and Commerce, Philadelphia. The study is wholly financed by the Textile Foundation. Chairman Blanchard reports as follows on the progress of this study:

"Corollary with the appraisal of mill inventory policies has been the task of finding out what has been happening to mill inventories in relation to those of converters, fabricators, and distributors. To this end, both long and short-run changes in inventories and related factors have been studied. The trend of inventories carried over the last 10 to 15 years, in relation to volume of business, has been measured for representative lines of textile production and distribution. To trace the relation of short-run changes, the sales, stocks and commitments of leading large-scale distributors are being studied in conjunction with similar data from mill groups for selected lines of textile items including cotton piece goods, women's hosiery, and men's clothing, and covering the period 1935–1938. While no definite time can be set for the completion of this study, it is expected that it will be completed by the end of this year."

* * *

Course in Industrial Statistics

A SUMMER COURSE in industrial statistics is to be conducted at Massachusetts Institute of Technology, Cambridge, Mass., from September 4–14, inclusive, under the direction of Prof. George P. Wadsworth. Dept. of Mathematics, and Prof. Harold A. Freeman, Dept. of Economics. There is a tuition fee of $30 and a registration fee of $5; registration is to be limited to 20 persons.

This course is intended for workers in industrial plants and scientific laboratories who would like to acquire the rudiments of modern statistical technique as applied to the design and analysis of laboratory experiments and to the control of the quality of industrial products. The course will include lectures, discussions, and laboratory work in large-sample statistics,

elementary small-sample theory, correlation and the analysis of variability in quality. These methods will be applied to practical problems brought to the course by those attending and to problems analyzed at the Institute during the past several years. Each person attending this course will be expected to have read in advance "The Application of Statistical Methods to Industrial Standardization and Quality Control" by Egon Pearson. This is available through the American Standards Association, 29 West 39th Street, New York City. Price $1.85.

* * *

Personal

Herbert J. Ball, head of the Department of Textile Engineering, Lowell (Mass.) Textile Institute, and chairman of Committee D–13 of the American Society for Testing Materials, was elected vice-president of that Society at its recent annual meeting in Atlantic City. He had served as a member of the Executive Committee during 1934–36 and again for 1939–40.

* * *

Roland Derby, for many years chief chemist at M. T. Stevens & Sons Co., woolen manufacturers, North Andover, Mass., is now engaged as a textile chemist and consultant with offices in the Everett Mill, Lawrence, Mass.

* * *

Dr. Wanda K. Farr, who had been in charge for several years of the cellulose research conducted under the auspices of the Chemical Foundation at Boyce-Thompson Plant Institute, Yonkers, N. Y., is now associated with the Research Dept. of American Cyanamid & Chemical Corp. The Chemical Foundation's cellulose research has been discontinued.

* * *

Giles E. Hopkins, former director of the Institute, and then technical director of Bigelow-Sanford Carpet Co., has been appointed technical director of the United States Asbestos Division of Raybestos-Manhattan, Inc., at their Manheim, Pa., laboratories. Prior to the latter appointment he had been with the United Shoe Machinery Co.

* * *

Charles J. Huber, associated for many years with the U. S. Testing Co., Hoboken, N. J., has been elected vice-president of that company in charge of engineering and research. Other officers of the company, including Daniel E. Douty, President, were reëlected at the recent annual meeting.

* * *

Harold Jaques, director of J. Emsley & Company, Ltd., cotton spinners, Manchester, England, is the new president of the Textile Institute with headquarters in Manchester.

* * *

Dr. S. J. Kennedy, director of market research, Pacific Mills, New York, and author of "Textile Markets" recently published as the report of the Committee on Textile Price Research of the National Bureau of Economic Research, of which committee Dr. Kennedy is chairman, is to conduct a course on "Merchandising and Marketing Textiles" at Columbia University next fall. The course will consist of 15 lectures to be given on Tuesday evenings.

(*Continued on page 424*)

The Relation of Cation Exchange to the Acidic Properties of Cotton

By ARNOLD M. SOOKNE and MILTON HARRIS *

A Textile Foundation Publication

Abstract

It has long been known that cellulosic materials exhibit acidic properties which influence many of their physical and chemical characteristics. Thus, the acidic groups of the fibre bind small amounts of ash which have a considerable effect on the electrical conductivity of cotton fibres, and on the viscosities of solutions of some cellulose derivatives. The ash may also affect the dyeing properties of the fibre, and may be related to the application of finishing agents. Since the ash of washed cotton consists principally of cations held by acidic groups, the problems of measuring the ash and the number of acidic groups on the fibre are intimately related. In addition, if some of the acidic groups of purified cotton are a part of the cellulose molecule, such as end-groups, the number of these groups may be a measure of its chain length, which is of primary importance in determining the strength and other physical characteristics of the fibre.

As part of a general program for the investigation of the acidic and basic properties of textile fibres, a study has been made of the manner in which hydrochloric acid is bound by cotton, and of the dependence of the amount of acid bound on the concentration of the acid solution in contact with the fibre. The effect on this dependence of different amounts of an added neutral salt, potassium chloride, has also been studied.

A comparison of the acid bound with the cationic ash (the total content of the cations of inorganic bases) as determined by an electrodialysis method leads to the conclusion that the maximum *acid-binding capacity is equivalent to the cationic ash, and that therefore the acid bound at any acidity depends upon the ash. A comparison of the results for dewaxed cotton with those for depectinized cotton shows that most of the acidic groups of cotton are contributed by the pectic substance.*

Cotton freed of pectic substance retains a small number of acidic groups. Although other possibilities exist, it seems likely that these are an integral part of the cellulose molecule, such as an end-group. If this is actually the case, the results show that the

* Research Associates at the National Bureau of Standards, representing the Textile Foundation, Inc.

cotton cellulose molecule has an equivalent weight of about 100,000 which corresponds to a minimum chain length of about 600 glucose residues.

I. Introduction

COTTON and other naturally-occurring cellulosic materials yield, on ignition, an ash which is alkaline in reaction. This results from the fact that the fibre normally exists as a salt, many of the anions being provided by the cellulose of the fibre and by associated materials such as pectic substance.[1, 2, 3] The cations in water-washed cotton have been shown by Walker and Quell to consist principally of Ca^{++}, Mg^{++}, Fe^{+++}, and Al^{+++}.[2] In addition, raw cotton also contains a quantity of neutral salt, most of which is removed during washing of the fibre with water.

The manner in which cotton binds acid may be considered as an exchange process between the hydrogen ions of the acid and the cations associated with the fibre. The extent of the exchange is a function of the number and nature of the cations, the concentration of the acid, and the tendency of the hydrogen of the acidic groups in the cotton to ionize. This concept of cation exchange has been employed from time to time by earlier investigators to explain the reaction of cellulosic materials with acids and salts.[1, 2, 3, 4] The importance and wide applicability of these exchange reactions have been recognized and discussed by McLean and Wooten[3] who demonstrated that the amount of acid bound by different cellulosic materials at an arbitrary pH is proportional to their ash contents. They also suggested that the major portion of the ash is contributed by non-cellulosic materials associated with the cellulose.

In the present investigation, which involved a detailed study of the acid-binding capacity of cotton fibres over a wide range of pH values, it is shown that the acid-binding capacity of cotton at any pH is determined by its cationic ash. From the complete titration curves, and the hydrogen ion equivalence of the ash, the maximum acid bound by different samples of cotton was ascertained, which in turn permitted the quantitative allocation of the acid bound to the principal constituents of the fibre.

II. Experimental Procedure

1. Materials

Raw cotton was extracted with hot alcohol for 24 hours, and then washed thoroughly with distilled water at room temperature for several hours. Such samples will henceforth be described as *dewaxed cotton.*

A portion of the dewaxed material was further purified by extraction for 4 or 8 hours with a boiling 1% solution of sodium hydroxide, according to the method recommended for the preparation of standard cellulose. The procedure was essentially the same as that described by Corey and Gray[5] except that the apparatus of Worner and Mease[6] was used. Fibres treated in this way were shown by the method of Whistler, Martin, and Harris[7] to be free of pectic substance. In one step of this purification the fibres were washed with a dilute solution of acetic acid. This undoubtedly removed some of the cations from the fibre and since cotton binds acid by a cation-exchange process which involves the back titration of the acid groups of the fibre by an added acid, it was necessary to make certain that all of the

acidic groups were in the salt form. This was accomplished by soaking the purified samples for about 3 hours in a solution of calcium hydroxide at room temperature. They were then washed in running distilled water for about 24 hours. Cotton from which both wax and pectic substance were removed is designated *depectinized cotton.* Depectinized cotton which has been washed with a solution of calcium hydroxide is designated *lime-washed depectinized cotton.*

All samples were conditioned at 21° C. and 65% relative humidity before weighing. The moisture contents of the fibres were determined by drying representative samples at 105° C. for 2 hours in a vacuum oven.

2. *Methods*

(a) *Determination of the acid-binding capacity.* Samples of cotton weighing about 5 g. and containing a known amount of moisture were immersed in 100-ml. portions of the acid solutions at the temperature of the experiment (0° or 25° C.). Large test-tubes ($1\frac{1}{2}'' \times 8''$) were found to be convenient for this purpose, since the samples could be easily pressed into the bottom of the tube to insure uniform wetting of the fibres or to permit squeezing the liquor from the fibres after equilibrium was reached. The amount of acid absorbed was determined by titration with sodium hydroxide of 50-ml. aliquots of the original solution and of the solution in equilibrium with the sample, using bromcresol purple as the indicator. From the difference between these titers, the weight of the sample, and its content of moisture, the amount of acid taken up per gram of dry cotton was calculated. In a number of measurements, the concentrations of strongly acid solutions (in the region of pH 1) were determined by adding a weighed quantity of strong alkali to the solution, after which the titration was completed with weak acid or alkali.

Preliminary measurements at several acidities indicated that a close approximation to a final equilibrium is attained in a few hours. In most of the experiments, however, the samples were allowed to remain in contact with the solutions overnight.

(b) *Determination of pH.* Measurements of pH were made with a McInnes and Belcher-type glass electrode and a vacuum-tube potentiometer, using a cathode-ray "eye" as null indicator. The pH values were referred to potassium acid phthalate, 0.05 *M*, to which was assigned a pH value of 4.01.[8]

(c) *Temperature.* With the exception of one experiment at 25° ± .02° C., all of the acid solutions in contact with the cotton were kept at 0° ± .01° C. to inhibit decomposition of the fibres.

(d) *Determination of cationic ash.* The hydrogen ion equivalence of the cationic ash was determined by an electrodialysis method described elsewhere.[9]

III. Results and Discussion

1. *Selective sorption of water by cotton*

The determination of the maximum acid-binding capacity of cellulose is complicated by the fact that the fibres may selectively sorb water from a solution of acid, and thus affect its titer. Since the acid-binding capacity

is calculated from titer differences, a correction must be applied to compensate for this effect. At pH values below 1.5, the magnitude of the correction is appreciable compared with the acid-binding capacity of cotton, but becomes negligible at pH values above 2.5.

If B is the amount of water selectively sorbed per gram of dry cotton, then the amount sorbed per gram from the solution by a sample which originally contains W g. of water per gram is (B — W). Water taken up in this manner is no longer available for dilution of the acid, and would thus tend to cause an increase in concentration of the acid solution in contact with the fibre. At the same time, however, a quantity of acid A (milliequivalents per gram), will be bound by the sample, and produce a decrease in concentration of the acid solution. Obviously, if any of the acid solution as such is dissolved in the sample, the titer of the solution will not be affected. From the above, it follows that if S g. of dry cotton are immersed in G ml. of acid solution of concentration C_o, and the concentration of the solution after equilibrium is attained is C, the corrected acid-binding capacity of the cotton is given by the equation,

$$A = \frac{G(C_o - C)}{S} + C(B - W) \qquad (1)$$

where A is the corrected acid-binding capacity $\frac{G(C_o - C)}{S}$ is the apparent acid-binding capacity, and C(B — W) is the correction for the selective sorption of water.

The actual measurement of the quantity B presents considerable experimental difficulty. In the region of the maximum acid-binding capacity, measurement of titer differences in solutions of different initial acid concentrations, or in solutions of the same initial acid concentration which have been allowed to come to equilibrium with samples of different moisture contents, gives equations of the form of equation (1). The solution of any two of such equations should give values for A and B, but such a procedure demands the assumption that both A and B are constant for the conditions employed. Measurements made in 0.1 and 0.2 *M* solutions of hydrochloric acid indicated that this assumption is not valid. The results were such as to indicate that more acid or less water was sorbed in the more concentrated of these solutions. If calculations are made from measurements of solutions for which the above assumption should be more nearly valid (0.10 and 0.11 *M* solutions of hydrochloric acid) the values for A and B are too sensitive to experimental error to be useful.

It was found, however, that the following method for evaluating A and B leads to less equivocal results. A substance which is assumed not to be sorbed by the fibre was added to the solution of acid as a reference substance. The change in concentration of this substance gives a direct measure of the amount of water (B — W) sorbed by the fibre. Two reference substances, sodium chloride and trehalose, were used in this work. The change in concentration of the former was determined by evaporating an aliquot of the solution and determining the dry weight of salt. In the case of the disaccharide, trehalose, the change in concentration was measured polarimetrically. The actual determinations were made as follows. Samples of cotton of known weights and moisture contents were immersed in solutions that were 0.1 *M* with respect to hydrochloric acid, and 3.43 *M* with

respect to sodium chloride, and the changes in concentration of both acid and salt were determined. The acid-binding capacity, A, was then calculated, due account being taken of the water sorbed as determined by the change in salt concentration. The mean of four values, so determined, was 0.067 milliequivalent per gram.

The value for B in solutions in the region of pH 1 was then calculated by substituting the value 0.067 for A in equation 1. The value $(C_o - C)$ is small, and therefore the determination of B by this procedure is subject to the uncertainty of this quantity. In order to improve the reliability of B, a series of 20 samples of dewaxed cotton of known weights and moisture contents was immersed in solutions of hydrochloric acid of known concentrations, the acidities of which were in the region of pH 1. The 20 equations of the form of equation (1), obtained from these measurements, were summed up and gave the equation,

$$28.63A - 3.87B = 1.489 \qquad (2)$$

Substitution of the value of 0.067 for A in equation (2) gave a value for B (in HCl solution) of 0.11 g. of water per gram of dry cotton.

The values of A and B were also determined by a second method, in which trehalose was used as the reference substance. Samples of cotton of known weights and moisture contents were immersed in trehalose solutions that were 0.04 *M* with respect to hydrochloric acid. The concentration of trehalose before and after the introduction of the samples was measured polarimetrically. By this procedure, a value for B of 0.13 g. of water per gram of dry cotton was obtained.

The validity of this method of correction for the selective sorption of water is shown in Table 1, which presents data on dewaxed fibres of widely

TABLE 1

Application of the correction for the selective sorption of water to the acid-binding capacity of dewaxed cotton in 0.1 *M* hydrochloric acid.

Initial water content	Apparent acid-binding capacity $\frac{B(C_o - C)}{S}$	Correction $C(B - W)$	Corrected acid-binding capacity A
g./g. cotton	milliequiv./g.	milliequiv./g.	milliequiv./g.
0.000	0.054	+0.012	0.066
.100	.063	+ .002	.065
.190	.075	− .007	.068
.308	.085	− .019	.066
.720	.124	− .059	.065
1.135	.164	− .097	.067
			0.066 Mean

different initial moisture contents. The measurements were made in 0.1 *M* solutions of hydrochloric acid, and the results are corrected using the mean value, 0.12 for B. Each figure represents the mean of at least two determinations. In the cases of the samples of high moisture contents, some

of the water was added directly to the solution with the sample. The discordant values for the apparent acid-binding capacity, $\frac{G(C_o - C)}{S}$ for all of these samples are brought into close agreement by application of the correction C(B — W) to give the corrected acid-binding capacity, A.

It is of interest to note that the values for B, 0.11 and 0.13 g. of water per gram of dry cotton, are considerably lower than the known moisture content of cotton at relative humidities between 99 and 100% (about 0.3 g. of water per gram of cotton),[10] which corresponds approximately to the humidity of air in equilibrium with 0.1 *M* hydrochloric acid. The result suggests that the average partition coefficient of the hydrochloric acid between the water in the external solution and the water held by the fibre is greater than unity. The average value of B of 0.12 g. of water per gram of cotton represents the portion of the total sorbed water which is unavailable for dilution of the acid.

2. *Combination of dewaxed and of lime-washed, depectinized cotton with hydrochloric acid*

Measurements of the combination of dewaxed and of lime-washed, depectinized cotton with hydrochloric acid are given in Table 2 and shown graphically in Fig. 1. The data were obtained in the absence of added salt, and in solutions made up to 0.1 *M* and 1.0 *M* ionic strengths with potassium chloride. The increase of ionic strength from 0.1 to 1.0 *M* produced no measurable effect on the titration curve of either sample, and accordingly only one curve is drawn for each sample at the two ionic strengths. The curves for dewaxed and for lime-washed, depectinized cotton tended to approach maxima, at about pH 1, of 0.066 and 0.008 milliequivalent per gram, respectively. The failure to arrive at unambiguous maxima may be due to the uncertainty in the correction for the selective sorption of water or to other secondary effects which may occur in solutions of high acid concentrations.

None of the pectic substance appeared to dissolve during the titration with acid. This was indicated by sharp indicator endpoints, lack of frothing, exact correspondence between acid-binding capacity calculated from pH differences and from titer differences, and the pH of 0.1 *M* potassium chloride solution in contact with the sample (about 5.3). If any soluble potassium pectate had been formed, the pH value of the solution would necessarily have been appreciably higher. The pectic substance may be insoluble because it exists as an insoluble salt of polyvalent cations or as the free acid, which is insoluble in acid solutions.

The difference between the maxima of the curves indicates that about 85% of the acid groups of dewaxed cotton is furnished by the pectic substance. This conclusion is confirmed by direct chemical analyses presented elsewhere. The remaining acid groups appear to be associated with the depectinized cotton. Further consideration of these groups and their probable significance is given later.

The titration curves for dewaxed cotton (curves 1 and 2, Fig. 1) must be considered as composites of the curves for depectinized cotton and the pectic substance. Accordingly, subtraction, at corresponding values of pH, of the ordinates of curve 3 from those of curve 1 should give a titration

TABLE 2

Combination of dewaxed and of lime-washed, depectinized cotton with hydrochloric acid at 0° C, in the presence of varying amounts of potassium chloride.

Dewaxed Cotton

No added salt		0.1 *M* ionic strength		1.0 *M* ionic strength	
pH	acid bound	pH	acid bound	pH	acid bound
	milliequiv./g.		milliequiv./g.		milliequiv./g.
1.08	0.066	1.08	0.066	2.03	0.056
1.47	.061	1.48	.062	2.55	.046
1.96	.058	1.98	.057	3.06	.036
2.47	.052	2.45	.048	3.56	.024
3.05	.041	2.94	.040	4.05	.012
3.64	.025	3.39	.030	4.62	.005
4.45	.011	3.70	.018	5.24	.001
5.22	.004	4.02	.011	5.72	.000
5.78	.001	4.44	.006		
6.04	.000	4.52	.004		
6.30	.000	4.69	.003		
		5.20	−.001		

Lime-washed Depectinized (4 hr.) Cotton

1.08	0.008	1.08	0.008	2.04	0.006
1.51	.007	1.53	.005	3.00	.004
2.04	.006	2.36	.003	4.03	.001
2.52	.005	3.15	.002	5.18	.000
3.00	.004	3.90	.001	5.84	.000
3.48	.004	4.16	.001		
4.09	.003	4.63	.000		
4.71	.002	5.52	.000		
5.67	.000				
6.27	.000				
6.38	.000				

curve for the pectic substance in the absence of added salt. Similarly, subtraction of the ordinates of curve 4 from those of curve 3 gives the curve for pectic substance in the presence of added salt (0.1 or 1.0 *M* potassium chloride). The data thus obtained interpolated at intervals of 0.5 pH unit, are shown by the points in Fig. 2. The smooth curves in this figure are not drawn to fit these points, but are explained in Section III–6. It should be noted that the data obtained by the subtraction process described above are not subject to errors inherent in the method of correction for the selective sorption of water by the samples, since the subtraction would presumably cancel any such errors. Furthermore these results

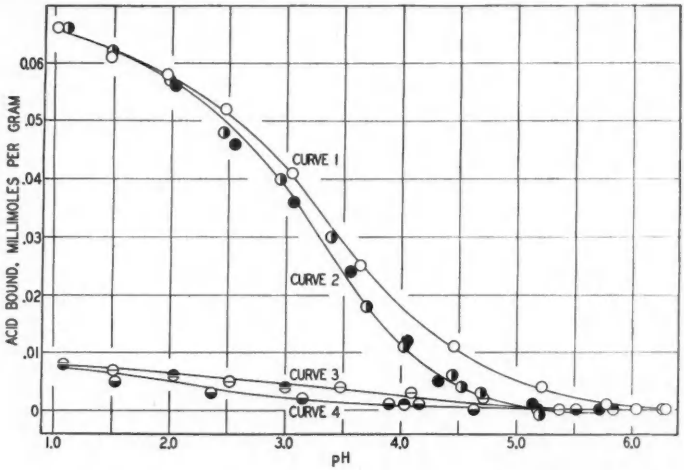

Fig. 1. Combination of dewaxed and of lime-washed depectinized cotton with hydrochloric acid at 0° C. Curve 1, dewaxed cotton in the absence of added salt, ○. Curve 2, dewaxed cotton in hydrochloric acid-potassium chloride solution of 0.1 *M* ionic strength, ◑; and in solutions of 1.0 *M* ionic strength, ●. Curve 3, depectinized cotton in the absence of added salt, ⊖. Curve 4, depectinized cotton in solutions of 0.1 *M* ionic strength, ◒; and in solutions of 1.0 *M* ionic strength, ◓.

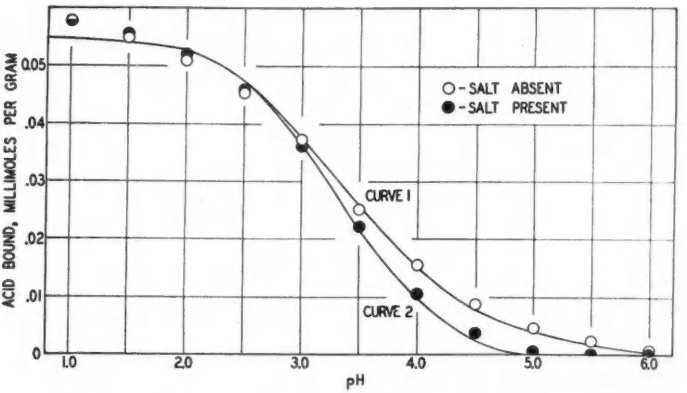

Fig. 2. Calculated data for the combination of pectic substance with hydrochloric acid at 0° C. Curve 1, pectic substance in the absence of added salt, ○. Curve 2, pectic substance in solutions of 0.1 *M* or 1.0 *M* ionic strength, ●. The smooth curves are not drawn to fit the data, but are explained in the text (Section III–6).

should not be susceptible to secondary effects (Section III–2) for the same reason. As a result, it is not surprising that a somewhat more definite maximum is obtained. The curve approaches a maximum value of 0.058 milliequivalent per gram.

3. *The hydrogen ion equivalence of the cationic ashes of dewaxed and of lime-washed, depectinized cottons*

The hydrogen-ion equivalence of the cationic ashes of several different samples of cotton are given in Table 3. A comparison of the data for the ash determinations on dewaxed cotton with those on dewaxed cotton which had been washed with lime water and then with distilled water indicate that all of the acidic groups in the former existed in the form of salts.

TABLE 3

The hydrogen-ion equivalence of the ashes of various cotton samples.

Sample	Cationic ash milliequiv./g.
Dewaxed cotton	0.063
Lime-washed dewaxed cotton	.064
Lime-washed depectinized (4 hr.) cotton	.010
Lime-washed depectinized (8 hr.) cotton	.010

The data also show that if the extraction is extended from 4 to 8 hours, the cationic ashes of the lime-washed samples remain unaltered. The difference between the mean values of the cationic ashes of dewaxed and of lime-washed, depectinized cottons is 0.054 milliequivalent per gram. This represents the catonic ash bound by the pectic substance.

A comparison is given in Table 4 of the maximum acid-binding capacities of dewaxed cotton, lime washed, depectinized cotton, and the pectic substance with their respective cationic ashes. The correspondence is very

TABLE 4

Comparison of the maximum acid-binding capacities of various samples with their contents of cationic ash.

Sample	Maximum acid-binding capacity milliequiv./g.	Cationic ash milliequiv./g.
Dewaxed cotton	0.066	0.063
Lime-washed depectinized cotton	.008	.010
Pectic substance (calculated)	.058	.054

close for each sample. In addition to the excellent agreement obtained by the two methods, these values also agree well with independent determinations.* Calculation of the data of Walker and Quell [2] for the total cationic ash as obtained by direct methods, in samples of water-washed cotton, gave

* Further investigations now in progress in this laboratory, indicate that these values are also approximately checked by direct titration with alkali, of samples of cotton freed of catonic ash by electrodialysis.

a value of about 0.064 milliequivalent per gram. Similarly, direct determinations of the uronic acid-carboxyl content, by the method of Whistler, Martin and Harris[7] of the cotton used in this work gave a value of 0.055 milliequivalent per gram. Since the entire uronic acid-carboxyl content of the cotton can be accounted for by titratable groups, the results suggest that the pectic substance exists on the fibre as the salts of pectic acid.

4. The temperature coefficient of the titration curve of dewaxed cotton

Table 5 gives the data for the titration curve at 25° C. of dewaxed cotton in the absence of added salt. These data are compared with the corresponding data for dewaxed cotton at 0° C. in Fig. 3. The results indi-

TABLE 5

Combination of dewaxed cotton with hydrochloric acid at 25° C in the absence of added salt.

pH	Acid bound milliequiv./g.
1.45	0.058
1.93	.058
2.45	.053
3.04	.041
3.75	.027
4.49	.012
5.32	.004
6.38	.001
6.54	.000

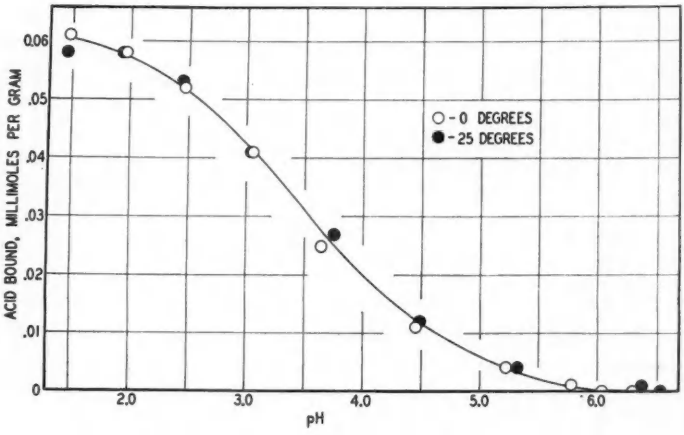

Fig. 3. Titration curves of dewaxed cotton at 0° and 25° C.

cate that there is no measurable temperature coefficient of the equilibrium values in this range of temperature, a result in keeping with the identification of the acidic groups of the fibre as carboxyl groups.[11]

5. *Significance of the acidic groups in depectinized cotton*

The results in the foregoing sections show that about 85% of the acidic groups in dewaxed cotton can be allocated to the pectic substance. The question arises, however, as to the source of the acidic groups in the depectinized cotton. The following explanations for their presence might be offered:

(1) Removal of the pectic substance by the alkali may be incomplete.
(2) The protein fraction of the cotton may have an appreciable acid-binding capacity.
(3) The acidic groups may be present in low molecular weight degradation products of cellulose.
(4) The acidic groups may be an integral part of the cellulose itself.

A comparison of the acid bound by samples of cotton which had been extracted with sodium hydroxide for 4 and 8 hours showed that both bound essentially the same maximum amount of acid. Since it has been shown by direct analyses for uronic acids that both samples were free of detectable amounts of pectic substance,[12] the first of the three possibilities is immediately ruled out. Furthermore, since increasing the duration of the alkali-treatment lowered the nitrogen content from 0.06 to $< 0.015\%$, and the maximum acid-binding capacities of the two samples are the same, it is difficult to see how the protein fraction could account for any substantial portion of the acid bound. The third possibility also appears unlikely because it would be expected that acidic compounds of low molecular weight would be readily removed during the treatment with alkali.

It therefore appears that the residual acidic groups in depectinized cotton may well be an integral part of the cellulose molecule, as for example, an end-group. Further work, which is necessary for establishing the validity of such a conclusion, is now in progress in this laboratory. By making the tentative assumption that these acidic groups are contained in the cellulose molecula and are present to the extent of about 0.010 milliequivalent per gram, as determined experimentally, it is found that the cellulose has an equivalent weight of about 100,000, which corresponds to a minimum chain length of about 600 glucose residues.

6. *The application of the Donnan theory to the titration curves of the pectic substance*

As shown in Figs. 1 and 2, addition of salt produced shifts in the positions of the titration curves to lower pH values. The direction of this shift and the fact that it is not measurably augmented by an increase of ionic strength to 1.0 *M* suggests that the results may be explained by the Donnan equilibrium. Calculation shows that any alternative mechanism involving the competition of cations for the carboxyl groups requires a still further shift with increased concentration of these ions.*

* The titration curves for wool have been shown to be consistent with an ion-association mechanism which involves the combination of cations other than

The derivations of the Donnan equations for the titration curves in the absence of salt and in solutions of hydrochloric acid and potassium chloride of 0.1 *M* ionic strength are given below. Bracketed quantities are molar concentrations. The density of the phase which consists of the pectic substance is taken as unity. The subscripts "o" and "i" refer to quantities in the outside (solution) and inside (pectic substance) phases, respectively. R is the ratio of the activity coefficient of an ion in the inside phase to its activity coefficient in the outside phase, referred to the same standard state, and is assumed to be the same for all the ions involved. This is a reasonable assumption only when all the ions bear similar charges. K is the ionization constant of the acid, α is the fraction of the total acid $[A^-] + [HA]$ in the ionized form $[A^-]$, V represents volume, and ρ equals $[H^+]_i/[H^+]_o$. The acid groups were assumed to be present as salts of the divalent metal *M*.[2] The positions and shapes of the curves are not affected much by the valence of *M*, in any case. The equations follow:

In the absence of added salt,

$$(3)\quad \frac{[H^+]_i R\alpha}{1-\alpha} = K$$

$$(4)\quad [H^+]_o[Cl^-]_o = [H^+]_i[Cl^-]_i R^2$$

$$(5)\quad [M^{++}]_o[Cl^-]_o^2 = [M^{++}]_i[Cl^-]_i^2 R^3$$

$$(6)\quad 2[M^{++}]_o + [H^+]_o = [Cl^-]_o$$

$$(7)\quad [A^-] + [Cl^-]_i = [H^+]_i + 2[M^{++}]_i$$

$$(8)\quad 2\frac{V_o}{V_i}[M^{++}]_o + 2[M^{++}]_i = [A^-] + [HA] = 0.055$$

These reduce to

$$(9)\quad \{[A^-] + [HA]\}\rho R^2\alpha^2 - \frac{\{[A^-] + [HA]\}(\rho^3R^3 - 1)}{\rho^2R + \frac{V_o}{V_i}}\alpha + \frac{(\rho^2R^2 - 1)K}{\rho R}(\alpha - 1) = 0$$

$$(10)\quad pH = pK + \log\frac{\rho R\alpha}{1-\alpha}$$

In hydrochloric acid-potassium chloride solutions of 0.1 *M* ionic strength,

$$(11)\quad \frac{[H]_i R\alpha}{(1-\alpha)} = K$$

$$(12)\quad [H^+]_o[Cl^-]_o = [H^+]_i[Cl^-]_i R^2$$

$$(13)\quad [M^{++}]_o[Cl^-]_o^2 = [M^{++}]_i[Cl^-]_i^2 R^3$$

$$(14)\quad [K^+]_o[Cl^-]_o = [K^+]_i[Cl^-]_i R^2$$

$$(15)\quad [K^+]_o + 2[M^{++}]_o + [H^+]_o = [Cl^-]_o = 0.1$$

$$(16)\quad [A^-] + [Cl^-]_i = [H^+]_i + [K^+]_i + 2[M^{++}]_i$$

$$(17)\quad 2\frac{V_o}{V_i}[M^{++}]_o + 2[M^{++}]_i = [A^-] + [HA] = 0.055$$

hydrogen ions with basic groups, and anions other than hydroxyl ions with acidic groups on the wool.[13] Since, according to this view, ions of unlike sign are bound by the fibre, the differences in ion concentrations inside and outside the wool phase which would be predicted by the simple application of the Donnan equations (taking into account the binding of hydrogen ions alone) would tend to be minimized, and may apparently be neglected. With cellulose, which is not amphoteric, there is no clear evidence for the existence of association of cations with carboxylate groups and a Donnan effect is therefore to be expected.

These reduce to the following equations, neglecting $2[M^{++}]_o$ in equation 15:

$$(18)\quad \alpha = \frac{0.1(\rho^2R^2 - 1)}{|[A] + [HA]|\rho R^2} + \frac{\rho^2 R}{\rho^2 R + \frac{V_o}{V_i}}$$

$$(19)\quad pH = pK + \log \frac{\rho R \alpha}{1 - \alpha}$$

Fig. 4 shows the calculated acid titration curves for the salt of a carboxylic acid of pK 3.3 present to the extent of 0.055 milliequivalent per ml.* These curves were calculated by varying the parameter ρ, and taking R as unity. Curve 1 was calculated from equations 9 and 10 and curve 2 from equations 18 and 19. The latter curve is only very slightly altered by increasing the ionic strength from 0.1 to 1.0 *M*. From the shape of the curves and the direction of the pH shift (Fig. 4), it is seen that the titration data

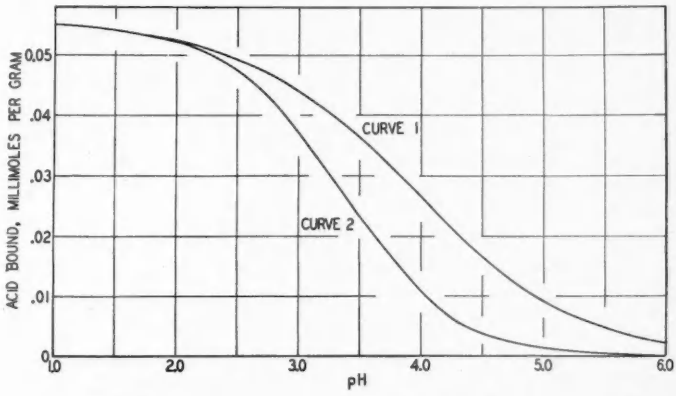

Fig. 4. Theoretical Donnan titration curves for an insoluble acid of pK 3.3 in the absence of added salt,—curve 1, and in solutions of 0.1 *M* ionic strength,—curve 2. The assumptions and conditions used are described in the text (Section III–6).

for the pectic substance (Fig. 2) are qualitatively consistent with the Donnan equilibrium, but the shift produced by the addition of salt is considerably smaller in the experimental curves than in the theoretical. It is interesting to note that the experimental data (circles) of Fig. 2 can be fitted very closely with calculated curves (solid lines) obtained by taking R equal to 0.05. It should be noted that R is present in each term of equations 9, 10, 18 and 19 in the relationship R/V_i. Therefore, the adjustment of either R or V_i can eliminate the discrepancy between the theoretical curves of Fig. 4 and the experimental data of Fig. 2. However, V_i has been fixed at the highest reasonable value by taking a value of unity for

* The value 0.055 milliequivalent per gram is the mean of the values for the maximum acid-binding capacity, cationic ash, and uronic acid carboxyl content of the pectic substance (Section III–3).

the specific volume, and the rather improbable value of R equals 0.05 is therefore required to make the calculated curves conform with the data.

Aside from the a priori unlikelihood of this value of R the agreement of the calculated curves with the data is subject to question on the following grounds. The solid lines of Figs. 2 and 4 represent the calculated amounts of acid fixed by the fibre by exchange with cations held by carboxyl groups. Experimentally determined acid-binding capacities are a measure of the *total* amount of acid adsorbed by the solid phase. If the value for R were 0.05, it would have as a consequence the presence within the solid phase of large quantities of dissolved acid at low values of pH, with resulting large discrepancies between the calculated and experimental values for the total amount of acid adsorbed. If the pectic substance is thought of as being dispersed throughout the fibre, which is rather unlikely,[14] the circles of Fig. 2 would represent only the acid fixed by the carboxyl groups, since they were calculated by a subtraction process that should cancel the effect of any acid dissolved in the fibre. For such a case, however, calculations show that there would be a sharp rise, not found by experiment, in the total amount of acid adsorbed by both the dewaxed and depectinized cotton at low values of pH (Fig. 1). If, on the other hand, the pectic substances is thought of as existing in a shell around the fibre, the subtraction process should not cancel the effect of the acid dissolved in the shell, and the circles of Fig. 2 should show a sharp rise at low values of pH, which was also not found experimentally. The quantitative agreement of the data of Fig. 2 with the curves cannot therefore be accepted as being too significant, but it is clearly shown that they are consistent with the Donnan equilibrium.

Because of the form of the function, the equation for the titration curve in the presence of salt (curve 2, Fig. 2) is virtually identical with the equation for the mass-action law for a monobasic acid of pK 3.3. This is merely an algebraic statement of the fact that the Donnan treatment predicts that, as the concentration of salt is increased, the differences between the ion concentrations of the inside and outside phases disappear, and a simple mass-action law is approximated. It is reasonable that the data for pectic substance in the presence of salt should be thus fitted by the mass-action law for an acid of pK 3.3, since pK values for other polyhydroxy acids are near this figure. Thus, glyceric and gluconic acids, e.g., have pK values near 3.5[15].

The authors are indebted to John Beek, Jr., for assistance in formulating the equations for the Donnan equilibrium.

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Obituary

Stuart W. Cramer, Sr., prominent in southern textile, civic and political life since 1893, when he became associated with the late D. A. Tompkins, Charlotte, N. C., founder of the village of Cramerton, N. C., and the cotton mills located there, and a director and treasurer since its authorization by Congress in 1930 of The Textile Foundation, died at his residence in Charlotte, N. C., after a long illness on July 2 at the age of 72. He was a graduate of the U. S. Naval Academy, Annapolis, and had studied later at the School of Mines, Columbia University. He was the southern representative of the Whitin Machine Works for many years, and under the title Stuart W. Cramer Co. engaged in mill engineering and the development of textile mill humidification. During this period he took out many patents relating to textile machinery and air conditioning. He also was the author of a series of four volumes entitled "Useful Information for Cotton Manufacturers." Mr. Cramer was a leader in textile associational work, and had been president of the American Cotton Manufacturers Association, and one of the organizers and an officer of the National Council of American Cotton Manufacturers, founded in 1912, and of the Cotton Textile Institute. As a Republican he was not only active in state politics, but was the member of many national bodies. In recognition of his work for an adequate tariff he received a special medal of the National Association of Cotton Manufacturers. Mr. Cramer was one of the preliminary directors of U. S. Institute for Textile Research, but resigned on his appointment in 1930 as a director of The Textile Foundation.

Mr. Cramer was born Mar. 31, 1868, the son of John Thomas, and Mary Jane (Thomas) Cramer, Thomasville, N. C. His father was a native of Pennsylvania, and served with a Pennsylvania regiment during the Civil War. Stuart W. Cramer, Sr., is survived by his third wife, Mrs. Rebecca (Tinkham) Cramer, the mother of his second son, George B., and also by Mrs. James Rowland Angell (Katherine Cramer) and Maj. Stuart W. Cramer, Jr., both children of his first wife, who was Bertha Hobart Berry of Portland, Maine, who died in 1895.

Determination of Regain of Sized Rayon Warps: Checking the Efficiency of One Type of Warp Conditioner

By WILLIAM E. YELLAND *

A Research of U. S. Institute for Textile Research, Inc.

Summary

A method is given for determination of the regain of entire warps immediately after slashing on the silk system. This method obviates the necessity of taking samples either from the warp during slashing or from the end of the warp immediately after sizing. The necessary samples can be obtained when the warp has woven in the loom as far as a convenient cut-mark.

The purpose of this set of experiments was to determine whether or not a warp conditioner installed at the front of the slasher was actually bringing the regain of the warps up to the desired value. In this case it was found that the capacity of the conditioner was much too small. Consequently it was merely cooling the warps and not conditioning them, and the warps were leaving the slasher with regains from 1 to 7%.

Introduction

IN an effort to minimize the effect of over-drying rayon warps during slashing some mills have installed a warp conditioner at the front of the slasher back of the loom warp beam. The type of conditioner studied in this investigation has a fan which blows a stream of cool moist air through the warp before the latter is wound up on the loom beam. The purpose of this operation is to cool the warp and restore to it the moisture lost by over-drying.

If the slasher is run with steam in the drying can nearest the front of the machine there is a tendency for the warp to leave the drying cans at a fairly high temperature, in this case 100° F., and to be wound up on the loom beam at that temperature if no conditioner is used. To the hand of the operator the warp feels warm and therefore seems to be dry. When a conditioner is used, the moist air stream from it is approximately 60° F. The warp in passing over the conditioner is cooled to about 70° F. and is

* Dr. Yelland was director at Massachusetts Institute of Technology of the filament viscose rayon phase of the warp sizing research from Jan. 1, 1936, to Sept. 30, 1938, and is now with Corn Products Refining Co., Research Laboratory, Edgewater, N. J.

then wound up on the loom beam. Consequently the warp feels cool to the operator's hand and he is apt to assume that it has more moisture than when it felt warm. He is therefore mislead into thinking that the warp has the proper regain when it is really much drier than it should be.

During a series of sizing experiments on pile warps used in the fabrication of transparent velvets it was found necessary to check on the efficiency of one of these warp conditioners. A simple method was devised for determining the regain which the whole warp had immediately after slashing. This method is described.

Procedure

1. Record the relative humidity of the warping room.
2. Weigh the unsized warp beam to 0.1 lb. as soon as it has been made.
3. Place the unsized warp beam in the back of the slasher.
4. Weigh an empty beam and place it in the front of the slasher.
5. Slash as usual.
6. Weigh the sized warp beam.
7. Weigh the empty beam from which the unsized warp was taken.
8. Remove samples for desizing from the sized beam and determine the per cent. size in the standard manner.

In subsequent work it was found convenient to take samples for size determinations in the following manner: The warp is allowed to weave in the loom until any convenient cut mark near the middle of the warp comes up. The loom is stopped and approximately one yard of warp yarn pulled through the loom by winding the yarn up on the cloth beam and at the same time releasing the let-off on the warp beam at the back of the loom. The loom is then started again and allowed to run normally. After a few more yards have been woven the sample can be taken off the cloth roll. If a few inches of woven fabric are left at end of the sample the latter is very easy to handle.

This method of sampling the warp permits one to obtain yarn from near the middle of the warp without interfering with the slashing operation, or disturbing the yarn between the leases which occur at each end of a warp prepared on the silk system. The samples obtained in this way are more representative than those taken at the ends of the warp. They can be used for load-elongation and cohesion studies as well as for size determinations.

The part of the sample reserved for regain determinations should *immediately* be put in an air-tight container and sealed carefully. The operator should handle the sample as little as possible. It is often advisable to wear rubber gloves to prevent moisture from the hands affecting the yarn. The regain is then determined in the standard manner and is recorded as the regain which the warp has under temperature and humidity conditions prevailing in the weave room.

Calculations

The weight of the unsized warp is obtained by subtracting the result obtained in (7) from the result obtained in (2). The weight of sized warp is obtained by subtracting (4) from (6). Since the unsized warp has been

made in a conditioned room the rayon will have the regain usual for the relative humidity of the warping room. From this can be calculated a "bone dry" weight which does not change during slashing. The weight of the sized warp is the sum of this "bone dry" weight plus the total weight of size on the warp plus the weight of moisture in the sized warp. The total weight of size is determined by multiplying the per cent. size by the "bone dry" weight of the warp. The weight of moisture is found, therefore, by subtracting the weight of the size and the "bone dry" weight from the weight of the sized warp. A typical result is calculated:

1. Relative humidity of warping room = 65% (approximately)
2. Weight of unsized warp and beam = 102.0 lb.
4. Weight of empty beam for sized warp = 75.0 lb.
6. Weight of sized warp and beam = 96.6 lb.
7. Weight of empty beam from which unsized warp was taken = 78.2 lb.
8. Per cent size = 0.93%

Wt. of unsized warp = (1) − (7) = (102.0 − 78.2) = 23.8 lb.
At 65% R.H. viscose has a regain of approximately 13.1%
(Rayon and Synthetic Yarn Handbook, page 351, Second Edition)

$$\text{The bone dry weight} = \frac{23.8}{1 + 0.131} = 21.0 \text{ lb.}$$

$$\text{Total weight of size} = \left(21.0 \times \frac{0.93}{100} \right) = 0.2 \text{ lb.}$$

Wt. of sized warp = (6) − (4) = 96.6 − 75.0 = 21.6 lb.
Wt. of moisture in sized warp = (21.6 − 21.0 − 0.2) = 0.4 lb.

$$\text{Regain} = \frac{0.4 \times 100}{(21.0 + 0.2)} = 1.9 = 2\%$$

All weighings should be made on the same scale to 0.1 lb. The warp should be weighed immediately after warping and slashing. The values obtained are usually accurate to 1% regain. Since each value is based on the total warp weight it is a better indication of the regain of the warp than values obtained by determination of the regain of small samples taken from the warp. Variations in the relative humidity of the warping room from 65 to 70% R.H. do not cause a change of more than 1% in the regain values.

Needless to say this method is workable only when the warps are sized on the silk system, that is, when the whole warp is taken from a single beam in back of the slasher. When warps are sized on the cotton system with several beams in back of the slasher this method cannot be used as it is not possible to obtain the weight of a single warp only before slashing.

Results

In these experiments 18 warps were slashed and the regain of each warp determined. The values thus obtained varied from less than 1% to 7% with an average value of 2.6% (see Table 1). Samples were taken from these warps during weaving and the regain again calculated. The values obtained here varied from 13.0% to 14.6% with an average value of 13.9%. This means that the warps are leaving the slasher with about 11% regain *less* than what they should have in the weave room. Thus, although the conditioner is cooling the warp it is not restoring to it the amount of moisture the warp should have.

TABLE 1

Warp No.	Regain after Slashing	Regain in Weave Room
1	2%	14.2%
2	Less than 1%	13.9
3	7%	13.0
4	Less than 1%	14.6
5	" " 1%	13.6
6	" " 1%	13.9
7	" " 1%	14.6
8	" " 1%	13.8
9	4%	13.2
10	5%	14.2
11	4%	13.3
12	2%	13.5
13	5%	14.2
14	Less than 1%	14.3
15	" " 1%	13.7
16	4%	14.1
17	4%	14.4
18	Less than 1%	14.2
Average	2.6%	13.9%

Calculation of Increased Capacity Necessary for Conditioner

The capacity of the conditioner might be increased so as to supply moisture to the warp at a faster rate than it is now doing. A simple calculation will show that this new rate should be greater than the present rate by at least one-quarter of a pound of water per minute if the present drying conditions are maintained and the warp is to leave the slasher with the proper regain.

The average warp was 235 yards long and weighed about 20 lbs. The average regain was 2.6% and it should have been approximately 13.9%. To bring the warp to nearly the proper regain would require $20[(13.9 - 2.6)/100] = 2.3$ lbs. moisture. The warp is slashed at a rate of 25 yards per minute and the slashing time per warp is $235/25 = 9.4$ minutes. In this time 2.3 lbs. more moisture must be supplied. So the conditioner should have an increased capacity of $2.3/9.4 = 0.25$ lb. moisture per minute.

This article does not purport to state that the evils of excessive drying can be overcome by re-conditioning. It is intended, however, to point out that if a mill is using a conditioner the efficiency of the conditioner should be checked. The fact that the instrument is operating as a good cooling mechanism is no guarantee that it is also behaving as a satisfactory warp conditioner. This can only be determined by experimental methods. The method described is one which has been found satisfactory.

If the machine has too small a capacity to perform its conditioning job the manufacturer should be consulted. He will be able to suggest ways of increasing the capacity of the unit.

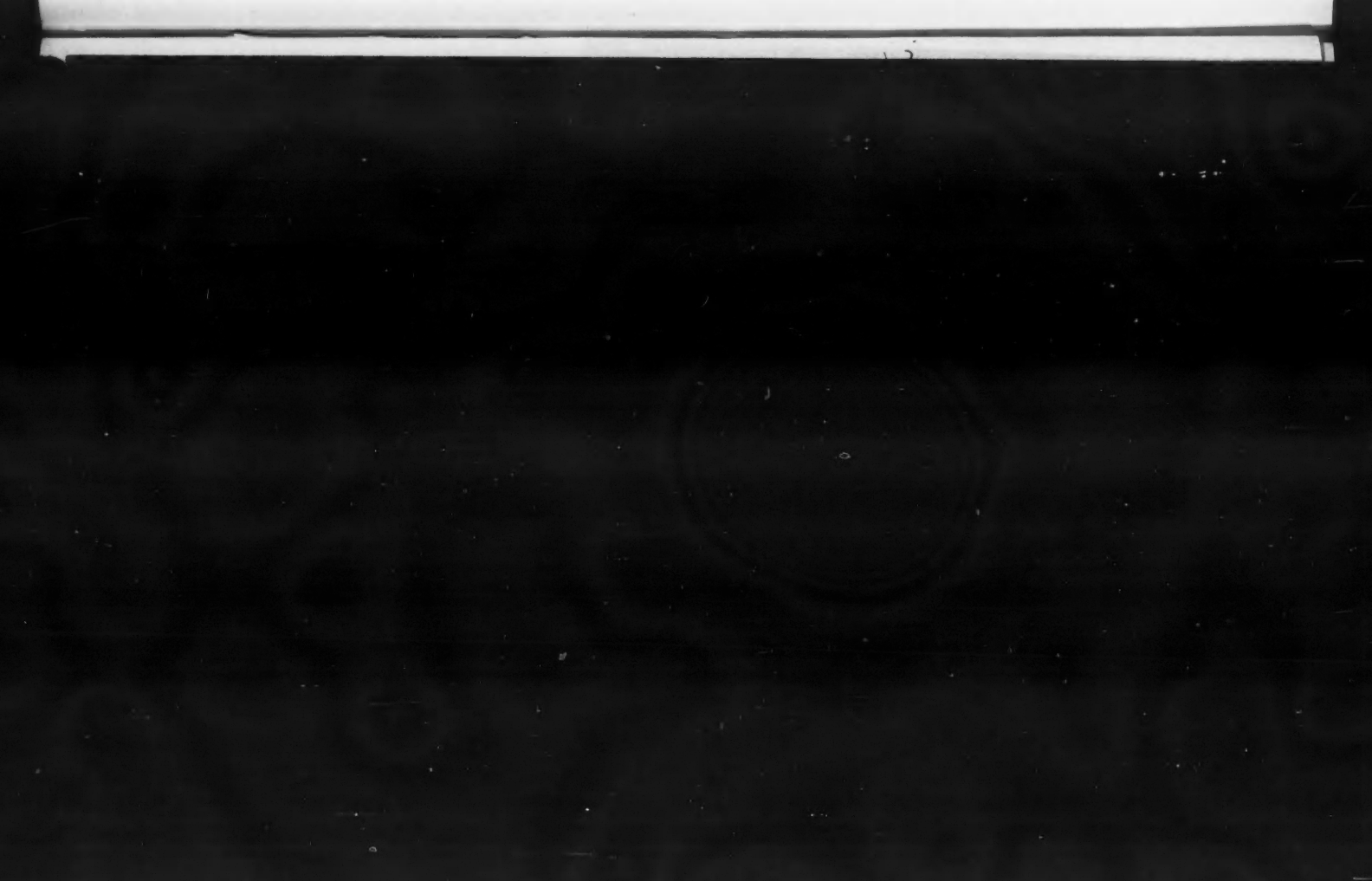
In this set of experiments no effort was made to correlate the weaving efficiency with the regain of the warps, as too many other variables such as amount and type of size were also involved.

Acknowledgment

The experiments on which this report is based were made possible through the courtesy of the Cheney Brothers, South Manchester, Conn., who offered to the Warp Sizing Project the use of their technical and laboratory facilities for a series of tests on the sizing of rayon pile warps. The writer wishes to express his appreciation and thanks for the use of those facilities and the whole-hearted co-operation of the staff of Cheney Brothers.

(*Continued from page 404*)

Roland L. Lee, Jr., associate cotton technologist, Div. of Cotton Marketing, U. S. Dept. of Agriculture, who has been in charge of spinning research work at Texas A. & M. College, College Station, Texas, has been appointed head of the Textile Engineering Dept., Texas Technological College, Lubbock, Tex., succeeding M. Earl Heard, who is now head of the Philadelphia Textile School. Mr. Lee is to be succeeded by John T. Wigington, now associated with the same division of the U. S. Dept. of Agriculture.



Compression Tests on Rayon Flock

By ERWIN J. SAXL *

Summary

The use of the Gelometer described previously has been extended to the measurements of rayon flock. By taking load-versus-compression readings in a precise and simple manner with the new Compressometer, the resistance of materials in bulk form to compression can be determined directly. Also, the elastic recovery and the work consumed in the total compression and decompression cycle can be found. In addition to evaluating constants of material, such as the influence of the length of the individual filament and the variations resulting from changes in diameter or denier, this method also permits the investigation of auxiliaries attached to the flock. This becomes of significance in sizing treatments of flock, and in the influence of chemical processes upon its resiliency. By following the manufacture of flock through with the aid of the "Compressometer," cutting and grinding methods may be investigated as they relate to the quality of the output desired and improvements may be made in the manufacturing procedure, resulting in a product of increased value to the consumer as well as a lower production cost.

Going beyond the industrial requirements, the compression tests described open up new vistas by furnishing a method whereby all types of small materials as such may be investigated in bulk form, and also the influence of the materials that fills the space between the particles.

Introduction

THE load-versus-compression characteristics of gelatins and allied sizing materials have been discussed in previous papers.[1, 2] Also, tests for the resiliency and other compressional characteristics of staple fibre, and of folded fabrics, rolled cloth and other materials have been described.[3, 4]

This paper concerns itself with an analysis of methods of compression measurements as they refer to rayon flock and other granular materials. A coördination of the results, with other flock testing methods, is attempted with the intent of linking different methods of investigation and the practical data observed with those obtained with the Compressometer.

As far as rayon flock is concerned, the data obtained with the aid of the Compressometer may be amplified by coördinating them in the proper

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manner with findings under the microscope or micro-projector. That is to say, the size of fibres or particles may be determined microscopically and their length and diameter distribution correlated with the Compressometer findings.

Rayon flock consists essentially of individual rayon filaments of short length. While it is technically impossible to produce an identical length throughout the sample, measurements under the microscope prove that under proper manufacturing procedures as much as 71% of the total amount of fibres present may have a length of ½ mm. or less. The samples compared in this paper are all of the viscose type of rayon and were all cut on the same stapling machine. In an analogous manner, other materials, such as cotton waste, and other methods of preparation, such as grinding, may be compared. Also, the influence of different finishing agents, such as coning oils, anti-crush resins, and the effect of moisture content upon the compressional characteristics and subsequent industrial behavior of flock may be investigated.

The advantage of the Compressometer in this connection lies in not only giving the dynamic characteristics completely but also in giving such measurements in bulk. The Compressometer automatically integrates over a great number of these small particles, thus giving in a short and simple test a representative picture, while microscopic readings require mathematical evaluation of a considerable number of individual readings if the results are to be truly representative of the lot.

Another advantage in using the Compressometer lies in the fact that it indirectly is indicative of the curliness of the individual fibres which can be investigated only with difficulty, by other means. Curliness improves the holding together of the fibres and moves the yield point upward. Curliness also improves the elasticity and influences the angle of ascent and descent of the loading-unloading curves as well as the area of the hysteresis loop, and thus the work factor.

These investigations assume practical significance because the use of flock in plastics is increasing steadily. From velvets to synthetic suede leather, from a filler for molded plastics to inside finishes of acoustical instruments, the applications of flock are legion and their use is increasing steadily. Moreover the same experimental method and reasoning applies to the use of the Compressometer in testing granular materials such as the 3-phase system soil-water-air.

In the actual application of flock in manufacturing practice, the resistance to compression and the elastic recovery, once pressure is removed from the specimen, are important from the manufacturer's viewpoint. These characteristics not only decide how much flock will fill a given space and thus influence the specific weight of the material delivered by the flock producer, but they also decide whether, for instance, a cloth covered with flock in a special manner will retain finger marks when pressure is exerted upon it, or whether it will recover its original appearance, like real suede leather.

In view of the fact that, as we will see later, different deniers of flock as well as different lengths influence the volume and the compressional characteristics, the following method was used for preparing a standard sample:

Method of Sampling

A 50-ml. glass beaker was filled with rayon flock.* The top of the beaker was evened off, first by drawing the edge of a ruler across it and thereafter by gently tapping the specimen so as to eliminate uneven distribution of air spaces within. By choosing a beaker of sufficient diameter the influence of any wall-effect is practically eliminated.

Under these conditions, a reasonably defined specimen is prepared which can be reproduced in shape, form and content at will so as to repeat measurements and check their reproducibility. There are, however, some hairs still protruding and other irregularities of the outer surface. In order to eliminate this last influence, a metal cylinder, weighing 50 g. and having a diameter of 1 in., is gently lowered upon the center of the sample and left there for one minute. By this means the last irregularities of the surface are now smoothed out and the specimen is ready for analysis in the universal Compressometer.

The Compressometer

While the principles of the Compressometer developed by the writer were described previously, certain improvements have been made recently that make it advisable to mention briefly the most up-to-date construction.†

In this instrument the compressional force is weighed by a triple-beam balance which has a sensitivity of 1/10th of one gram (Fig. 1). The specimen to be tested is placed upon the center of the pan of the balance. In order to read the pressure in grams directly and without calculation, a tare weight has been added, consisting of a cylinder with knurled ring which moves upon a spiral screw of sufficient thickness to give it rigid support along the length of the beam. By turning the tare weight, the distance between axle and weight may be changed at will. If all three weights are in their zero notches, then the weight of the sample may be eliminated from the readings by simply rotating the calibration cylinder until the pointer at the right end of the scale indicates equilibrium. The specimen is then balanced and all load readings are taken thereafter in direct load in grams and without having to subtract the weight of the specimen. Incidentally, having the tare weight adjusted once for a given type of specimen, a simple check-up is given simultaneously so that different specimens of bulk should balance reasonably well without change of the tare weight, provided the material is similar and has been prepared in an identical manner.

At the left side of the Compressometer provisions are made for having a holder move with the aid of a rack-and-pinion drive over a precision scale. By this means a sled holding the compressing plunger may be moved smoothly up and down. The distance of motion may be read upon the upright on the left with a precision of 1/10th mm. It will be understood, therefore, that all measurements are given directly in the gram-centimeter system, that is to say, grams-load versus centimeters-compression.

* Instead of glass, aluminum or other containers may be used, provided their design gives them sufficient mechanical strength to prevent their side-walls from bulging when the sample within the container is subjected to compression. Also, the ratio-diameter of the container versus diameter of the area tested should be sufficiently large so that wall effects are eliminated.

† In view of the fact that compression tests have a wide, general significance beyond the gelatin measurements made originally, use of the limited original name of Gelometer has now been superceded by the title Universal Compression Tester or Compressometer.

The sled with the aid of the rack-and-pinion drive is now brought to the position indicating zero. At this setting, the plunger as such is lowered separately by opening the knurled holding screw and lowering the rod until the surface of the plunger gently touches the surface of the specimen. This is indicated in five times enlargement by the pointer at the right side of the balance which then immediately moves upward. In this manner the initial point where the plunger touches the sample is determined with great exactness.

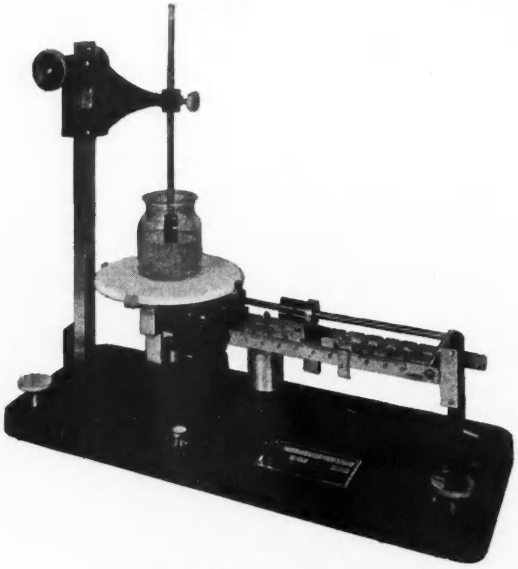

Fig. 1. Compression Tester.

The plunger is now clamped into position and the Compressometer is ready for the measurements. In order to avoid sudden shock to the specimen, the arrest at the right side of the balance is brought upward, simply by moving a spring-operated bayonet device at the right side of the balance indicator. With this holder in position, weights may now be brought out without the balance arm (and thus the specimen on the pan) moving. Depending upon the experience of previous runs, weight is placed now on such points and at such intervals that the critical points upon the dynamic characteristic (loading and unloading characteristics) are covered.

While the right hand pushes the arrest slowly down, the left hand of the operator moves the rack-and-pinion drive and thus the plunger, endeavoring at all times to keep the specimen free from jerks and the pointer of the balance remaining at zero. With this improved load-release the weight can be applied smoothly at all times. In this manner the distance which the plunger penetrates into the specimen under the given load can be measured directly.

In order to make the instrument as universally applicable as possible, the plunger consists of a circular bakelite piston of 0.5 in. diameter. This is the area standardized by the A. S. T. M. for the testing of gelatin and glue. It should be realized that the above is merely a practical detail and that the load-versus compression measurements described are *not* limited to plungers of this shape. Depending upon the material, larger or smaller diameters are advisable occasionally. Also, if the same instrument is to be used for greases or other plastic materials, standard cones, or needle-shaped plungers can be attached directly and simply. In this manner the same instrument can be used for the flock measurements described hereafter, and extends its usefulness simultaneously to the investigation of many other materials in plant and laboratory. *Compression tests are among the most universally applicable testing methods.* In this manner, load can be added smoothly, as well as removed, and it is simple therefore to plot complete loading-unloading curves and to determine also in repetition various points along these curves. In analogy to a suggestion made originally for filamentous materials, where similar characteristics were determined in the direction of stretch and relaxation from stretch, it is suggested here to also name the complete set of these curves "Dynamic Characteristics."[5]

Dynamic Characteristics of Flock

With the technique described the behavior which rayon flocks of different character showed when subjected to loading and unloading was investigated. This test closely compares with the handling of flock in the observer's hands. In pressing the flock, and then releasing it within the enclosure of the hand, a subjective test is made which is physically comparable to the compression-decompression test. The advantage of the latter, of course, is that it is more precise; is reproducible at all times; that the human element is eliminated; and that it is more sensitive and objective.

In order to separate the most important factors in the quality of materials, different runs were made to determine the dynamic characteristics of the same type of flock, keeping conditions always identical, with the exception of the one component to be investigated. Two different samples were selected, both consisting of viscose type rayon fibres, both cut under the same conditions and both showing under the microscope a large percentage of fibres the total length of which was ½ mm. or less. With everything else being identical it is possible then to investigate the influence of the denier (diameter) of the flock as it relates to the dynamic characteristics.

The loading cycles made in continuation of the loading experiment, and the values obtained, are shown in Fig. 2. As can be seen from the graph, an important difference exists between the two lots which is apparent even to the unskilled observer, and which readily permits their identification and the influence of different cutting and other manufacturing processes. Clearly shown is the greater softness of the thinner material and its lack of elastic recovery. In other words: *the higher the denier of otherwise identical rayon flock, the harder it is to compress. Also, the higher the denier, the more elastically does the material come back to its original shape after the acting load is removed.*

It will be seen that after a load of 200 grams is reached, the higher denier compresses to .48 cm. only, while the thinner, softer denier is com-

pressed twice as much, or to .96 cm. Upon removal of the load, the more elastic and springy higher denier returns elastically to a permanent deformation of .19 cm. only, while the softer fibres stay permanently deformed to the extent of .43 cm.

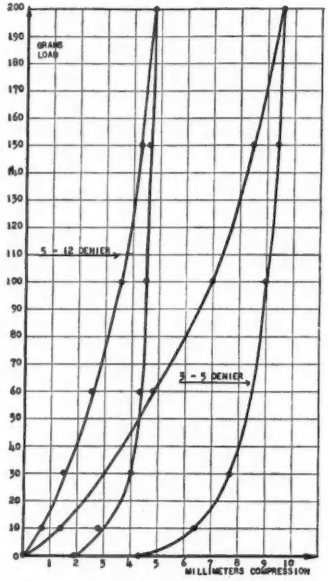

Fig. 2. Dynamic Characteristics for same Material and same Length but Different Deniers.

While compression in its final stage, and elastic recovery upon complete removal of the load, are satisfactory points of investigation for many routine purposes, and while it is extraordinarily simple and fast to determine just these two points for most practical intents, it is desirable in certain instances to determine experimentally the complete mechanical hysteresis loop and to get the added information which the entire loop presents. Comparable to the indicator diagram in a steam engine or internal combustion motor, this complete hysteresis loop gives the experienced technician an almost complete case history of the material with which he is dealing, and permits the prediction of changes as per different manufacturing processes and industrial applications of the finished product. All of these factors can be seen within one test run with a single precision instrument.

The evaluation of the hysteresis loop follows analogously the investigation of the hysteresis shape and area originally described for the measurement of stiffness.[6] Again, the areas may be integrated with the aid of

a planimeter, by weighing on an analytical balance, or by counting squares. From the above data, the work factor may again be determined and thus a quantitative comparison be made, not only in terms of distances and loads compressed, but in terms of the work necessary to arrive at a given compression. A discussion of the complete energy cycle can then be made. For details of the method, the reader is referred to the original paper.[6]

While the investigation of rayon flock was made in the previous analysis for identical material of the same length, although with different deniers, there is one more factor of primary importance for which a further investigation is indicated: It involves lots that are identical excepting for the length of the individual fibres. In this investigation two different lots were examined with the Compressometer that were identical to all practical intents and purposes in everything, except that one lot contained 71% of fibres that were 0.5 mm. or shorter, while the other had a fibre diagram (determined microscopically) which consisted of fibres, 66% of which were 0.5 mm. or longer.

It is evident from Fig. 3 that the change in the length diagram of the flock markedly influences the dynamic characteristics. It may be noted that the maximum range of Fig. 2 (denier comparison) is 200 grams load only, while Fig. 3 (length comparison) reaches to 800 grams. While in

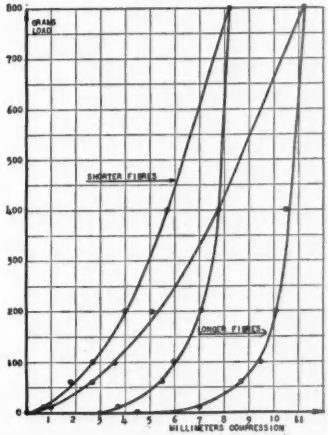

Fig. 3. Hysteresis Loops for same Material and same Denier but Different Lengths.

Fig. 2 it was shown that resistance to compression increases with increasing denier of the average fibre, it becomes clear from Fig. 3 that *stiffness and elasticity of flock in bulk improve as fibres get shorter.*

Quantitatively speaking, otherwise identical rayon fibres, 71% of which were 0.5 mm. long or shorter, compress under a load of 800 grams to .82 cm. only. On the other hand, the lot in which 66% of the fibres are 0.5 mm. or longer is softer, in that it compresses under the same conditions to 1.12 cm. Upon removal of the load the shorter fibres recover

better; that is to say to .3 cm., while the longer fibres retain as much as .45 cm. permanent deformation.

It also will be noted that there is an increase in the width of the hysteresis loop which characterizes the longer lot. This indicates that not only in resistance to compression and in the terms of permanent deformation is there a considerable difference between the two lots, but also in terms of the work factor resulting from the integration and comparison between the two loops in their entirety. From a practical viewpoint it is significant that the shorter lot produces a synthetic suede leather which, due to its elastic comeback, shows less fingermarks. On the other hand, due to its greater length and softness as shown on the Compressometer test, the longer lot produces a more velvety appearance of the finished product.

Some General Observations

Certain phenomena enter the Compressometer investigations that open possibilities for general research. For instance, the shorter the length of the fibre, the greater the ratio of fibre-surface to fibre-volume. Accordingly, the influence of agents that cling to the fibre surface is relatively greater when applied to short than to longer fibres. In the investigation of very short fibres (or of pigments) therefore, experimental conditions must be chosen that do not exceed the load at which the material yields and the plunger continues to penetrate into the flock, thus making a hole without additional load increase. This yield point as such, however, offers possibilities of investigation of an interesting nature, as it is related to the length of the fibres, to their physical and chemical properties, and to the medium with which they are coated (oils, resins, water). Also, the influence of the air space between the particles influences the results. Attention, therefore, should be called here to the fact that the mechanics of the gliding of small materials over each other can be investigated with the Compressometer. It opens for investigation with a simple and precise scientific instrument a host of phenomena which reach from the mechanics of soil motion and erosion to the resistance to compression and elastic recovery of rayon flock, cotton waste, and similar materials of different fibre length and particle size as used in the textile, paint, rubber, plastic, carbon, flour and allied industries. In addition to the influence of variations within the material proper, it is also possible to investigate, with the aid of identical material, the influence of the medium which may cover the particles partially or completely.

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5. Some Dynamic Properties of Filamentous Materials. *Text. Rsch.*, Oct., 1935, P. 519–37.

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Abstracts

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I. Fibres (Synthetic and Natural) and Fibre Analysis

Fibres: Properties of. C. L. Wall. *Text. Mfr.*, Dec. 1939, P. 536–8, 542.

II. The strength, extensibility, plasticity, etc., of fibres is considered from the aspect of possibilities arising from the potential energies between the atoms of various elements and with different arrangements of atoms. III. *Ibid.*, Jan. 1940, P. 28–9, 34. Further considerations of different atomic and group arrangements in fibres which account for the distinctions in properties of fibres and other materials and also of yarns and fabrics. IV. *Ibid.*, Feb., P. 71–2, 76. Influence of atomic fields between the side groups of molecular chains on the properties of systems of chains; ways in which the energy of the fields is varied, and results of varying the energy of the fields. V. *Ibid.*, Mar., P. 116–8. Energy effects between the structural units and applications in chemical and physical treatments in finishing and in spinning artificial fibres. VI. *Ibid.*, April, P. 158–60, 164. Structural requirements for formation of fibres superior in strength or other properties and some theoretical limits and methods in which they might be obtainable, and having dyeing and other permanent finishing capacities. (C)

Flemish Flax Technique. T. J. Crouch. *Irish Text. J.*, 1940, V. 6, No. 2, P. 2–3; abs. in *J. T. I.*, Mar. 1940, P. A123.

The experimental work of M. Soenens is described and the drying of retted flax straw is discussed. The aim of this work is to use a mechanical drying system under controlled conditions, thus eliminating the costly and hazardous method of open-air drying. The importance of such a drying

installation (which will deal with up to 12 tons of straw per day), is that flax may be retted and dried throughout the year. This means that scutching may be carried out at any time, and scutch mill owners will be able to minimize many risks previously encountered under old methods. The new process of water retting is also described and data are given relating to the new Soenens flax experimental station. Although the scheme is still in its infancy, it is suggested that it will be successful. Further work is in progress with a view to increasing efficiency and reducing costs. (C)

RAW AND SWOLLEN HEMP FIBRES: STRUCTURE. B. C. Kundu and R. D. Preston. *Proc. Roy. Soc.*, 1940, V. B128, P. 214–31; abs. in *J. T. I.*, April 1940, P. A202.

An anatomical study of the fine structure of phloem fibres in untreated and swollen hemp indicates a more or less transverse orientation of cellulose chains in the primary wall which become longitudinal in the adult fibre. The conception of a primary wall with longitudinally oriented chains at any stage of its existence seems to be at variance with many published opinions and the idea that cellulose chains may be changed in orientation during growth seems to be losing favor. In hemp, however, there is clear evidence that the bulk of the primary wall is composed of longitudinally directed cellulose chains. In this tenuous wall, however, there may occur layers (perhaps in a molecular sense) the chain direction of which is different. Consideration of growth in terms of wall extension seems to require a steepening of the chain direction in passing from an outer to an inner layer, particularly if wall deposition goes on by apposition rather than by intussusception. (C)

RETTING OF JUTE: CHEMICAL TECHNOLOGY OF. B. Kneer. *Klepzig's Textil-Z.*, 1939, V. 42, P. 543–6; abs. in *C. A.*, 1940, V. 34, Col. 1490.

A detailed description of chem. and mech. com. treatments. The retting bath contains usually mineral oil 10–12%, train oil 6–8%, soap 0.6–0.8%, soda 0.15% and water 79–82%. (C)

SHEEP RUGGING. *Rep. Waite Agric. Res. Inst., So. Australia*, 1937–38 (1939), P. 30–1; abs. in *J. T. I.*, Mar. 1940, P. A121.

Investigations were begun in 1935 at the Waite Agricultural Research Institute to determine the effect of rugging on the wool and body weight of sheep. Of 40 merino wethers of uniform age, weight and wool production, 20 were rugged with jute canvas after shearing in Sept. 1935, the remainder forming a control group. The sheep were weighed each month, and in the second year of the trial, staple length measurements were recorded for 10 sheep of each group every time they were weighed. It was found that the rugged wethers were always slightly heavier than those unrugged, but at no period was the difference in weight greater than 3 lb. per head. The rate of wool growth as determined by staple length measurements was uniform throughout the year for both groups. A table is given showing the wool production of the rugged and control sheep; this shows that there was no significant difference in the weight per head of greasy or of scoured wool between the two groups; the estimated "yield" of scoured wool obtainable from the greasy wool was slightly higher for the rugged sheep. (C)

SOYA BEAN FIBRE AND ITS IDENTIFICATION. Werner von Bergen. *Rayon Text. Mo.*, Nov. 1939, P. 45–7.

The author finds that soy bean fibre is about in the same status as Lanital was in 1935, *i.e.*, weak in strength. Its commercial possibilities are the same as those of rayon staple fibre and the soy bean fibre may become another competitor of wool which it approaches closely. (C)

STAPLE FIBRE: EFFECT OF HIGH TEMPERATURE ON STRENGTH AND EXTENSIBILITY. K. Breuer. *Kunstseide*, 1939, V. 21, P. 324–6; abs. in *J. T. I.*, Feb. 1940, P. A98.

Samples of different types of staple fibre were immersed in boiling water for half an hour and then lightly pressed in a cloth and dried in an oven at 60° C. This treatment produced no appreciable loss in strength but, except in the case of Vistra XT, some decrease in extensibility was observed. Samples of Rhodia, Cuprama and Lanusa fibres were immersed for a minute in water baths at temperatures ranging from 20 to 100° C. and then tested in the wet state. Curves showing the effects of the temperatures of the baths on the wet strengths and extensibilities of the fibres show decreases in strength and increases in extensibility with increasing temperatures, the changes becoming appreciable at temperatures below 40° in the case of acetate fibre, about 40° in the case of viscose fibre, and first at 60–70° in the case of cuprammonium fibre. These temperatures should, therefore, not be exceeded when washing staple fibre materials. Further samples of staple fibre were subjected to a drying treatment with hot air for a period of 5 hrs. and the effects of the drying temperature on the mechanical properties of the fibre were determined. Temperatures up to 105° produced no appreciable changes in dry strength and extensibility. At 140° the strengths of all the samples fell to 85% of their original values. Decreases in wet strengths and extensibilities also appeared after drying at 130–140°. The wet strength and the extensibility curves bend round at about 200°, showing that no further losses occur at higher temperatures, and in the case of the wet extensibility curves rises are shown above 200° and the wet extensibilities of fibres dried at 250° are nearly equal to those of fibres dried at 20°. Staple fibres become discolored on heating to high temperatures, the temperature at which discoloration first becomes apparent varying according to the type of fibre, and it is suggested that this effect might be used as a means of identification. Fusion at 230° C. is a characteristic of Rhodia fibre. (C)

II. YARNS AND FABRICS

PRE-TESTING DESIGNS. *Text. Wld.*, Oct. 1939, P. 70–1.

Photometric analysis substitutes camera eye and photo-electric cell for human fallibility; and supplements individual reactions with definite demonstrable facts. By its use relative advantages and disadvantages of contemplated patterns may be determined, and flaws and handicaps uncovered and corrected before the design is offered. (C)

PRINTING METALLIC EFFECTS ON ACETATE RAYON CLOTH. Raffaele Sansone. *Rayon Text. Mo.*, 1939, Sept., P. 89–90; Oct., P. 67–8. (C)

RAYON AND STAPLE FIBRE: ELECTRICAL INSULATING POWER. O. Pennenkamp. *Leipz. Monats. Text. Ind.*, 1939, V. 54, *Fachheft* III, P. 71–2; abs. in *J. T. I.*, Feb. 1940, P. A100.

The use of rayon and staple fibre yarns for covering electric wires and cables is discussed and the results of comparisons of the conductivities of silk and the various types of rayon are given. The data show that acetate rayon has a much smaller surface conductivity than silk. The acetate rayon, Aceta "P," is particularly suitable for insulation purposes. The viscose rayon product, Glanzstoff RT, can with advantage be used in place of the glace cotton yarn now used for covering cables. Special qualities of staple fibre yarns are also available for covering wires. (C)

RAYON STAPLE FIBRES: PROGRESS IN THE HISTORICAL DEVELOPMENT AND PATENTS OF. Edward C. Worden, 2nd. *Rayon Text. Mo.*, 1939, Sept., P. 66–7; Oct., P. 55–6; Nov., P. 53–5; Dec., P. 57–8; 1940, Jan., P. 61–2; Feb., P. 51–2.

A series of articles covering progress since 1937. (C)

RAYON WARP: SIZING. *Klepzig's Textil-Z.*, 1939, V. 42, P. 649–50; abs. in *J. T. I.*, Feb. 1940, P. A80.

The purposes of sizing, types of sizing equipment and the advantages of the air-drying type, sizing preparations and the disadvantages of oil sizes are briefly discussed. A size containing 5 kg. potato flour, 1 kg. fat and 1 kg. glycerin per 100 litres is recommended for both hank and warp sizing of rayon and the appropriate procedures are outlined. (C)

REGAIN OF TEXTILES AND HUMID ATMOSPHERE CHANGES. A. B. D. Cassie (British Wool Industries Research Assoc.). *J. T. I.*, Feb. 1940, P. T17–30.

The observation that textile fibres pick up and lose water vapor very rapidly is used to discuss water vapor and heat exchange between a humid atmosphere and the fibres. The results are fundamental for calculations on textile drying and conditioning processes, and examples of their application are given. The theory is also applied to physical problems of hygiene of clothing. It is shown that hygroscopic fibres can give protection against sudden temperature changes in normal humid atmospheres, and the protection increases with the slope of the regain—R.H. curve for the fibres. (C)

SIZING OF STAPLE RAYON AND RAYON: PRACTICAL EXPERIENCES IN. Karl Walter. *Deut. Wollen-Gewerbe*, 1939, V. 71, P. 1093–6, 1121–4; abs. in *C. A.*, 1940, V. 34, Col. 1183.

The desirable properties of a good size are enumerated, an appropriate sizing process is described, the advantages of the use of dryer sizing machine are discussed, and special sizing formulae are given. (C)

STAPLE FIBRE: COMBING. *Rusta*, 1940, V. 15, P. 23–4; abs. in *J. T. I.*, April 1940, P. A177.

A discussion of the combing of staple fibre on cotton combing machines, the use of the PC comber of the Société Alsacienne and of the Nasmith comber for this purpose, and the adjustment of the machines and the conditions necessary for good results. (C)

Staple Fibre, Cotton and Linen Mixture Fabrics: Utility and Resistance to Washing. Scheithauer. *Spinner u. Weber*, 1939, V. 57, No. 27, P. 5–6; No. 28, P. 7–10; abs. in *J. T. I.*, Oct. 1939, P. A663.

The use of staple fibre-cotton mixture yarns for the production of sheets, table cloths, handkerchiefs and similar materials is discussed and the importance of suitable fabric constructions and of suitable methods of washing is emphasized. Tables are given showing the effects of mild and severe washing treatments on the strength of cotton, linen, staple fibre-cotton, cottonized bast fibre-staple fibre, and cottonized bast fibre-cotton mixture fabrics. The data show that 1:5 mixtures of staple fibre and cotton have a resistance to washing similar to that of all-cotton fabrics but the loss in strength increases with increasing staple fibre content. Mixtures containing up to ⅓ staple fibre can be used satisfactorily for the types of fabrics mentioned and for those that are subjected to the least severe strains in wear it is possible to use mixtures containing up to ½ staple fibre. Fabrics woven from mixture yarns composed of half staple fibre and half cottonized bast fibre give results similar to those of all-linen fabrics and those made from half cotton and half cottonized bast fibres are equivalent in use to all-cotton fabrics. For bed ticking it is possible to use higher proportions of staple fibre and even 100% staple fibre yarns. Fabrics for mattress covers should have a high flexibility and as admixture of staple fibre with cotton reduces flexibility the use of such mixtures for this type of fabric, though possible, is not recommended. Staple fibre-cotton mixtures may be used for overall fabrics, the proportions in the mixtures varying according to the purposes for which they are used. Fitters' suits of half staple fibre and half cotton and half staple fibre and half cottonized bast fibre have given favorable results in washing and wear tests. (C)

Soil Retention of Various Fibres. C. H. Masland. *Rayon Text. Mo.*, 1939, Oct., P. 53–4; Nov., P. 68–70.

Gives suggestions as to changing fibres to meet special conditions of soilage. (C)

III. Chemical and Other Processing (Not Otherwise Classified)

Acetate-Rayon Burn-Out Printing. H. P. Baumann. *Text. Col.*, August 1939, V. 61, P. 522. (C)

Aeroplane Dopes: Composition and Qualities. F. W. Reinhart and G. M. Kline. *Ind. Eng. Chem.*, 1940, V. 32, P. 185–93.

Exposure tests on experimental dopes described previously lead to the following conclusions: (1) The choice of a satisfactory plastic base for a relatively non-inflammable aeroplane dope to replace nitrocellulose is limited to cellulose acetopropionate and acetobutyrate. (2) The optimum hydroxyl content of a mixed ester for use in an aeroplane dope is about 0.2 equivalent. (3) Solvent combinations can be formulated with cellulose acetate, cellulose acetopropionate, cellulose acetobutyrate and cellulose nitrate that lead to marked improvements in tautening and ageing of the dopes. (4) Aryl phosphate plasticizers with cellulose acetate, cellulose acetopro-

pionate and cellulose acetobutyrate generally produce better initial tautness, greater resistance to slackening in wet weather and less variation in tautness during exposure than other types of plasticizers. (5) A close correlation exists between the properties of the films and the behavior of the doped fabrics. (6) Doped fabrics on metal frames give less deflection, in general, than those on wooden frames. (C)

ALGINIC ACID: USE OF—IN MANUFACTURE OF PRINTING COLORS. V. I. Butin and V. V. Tavrovskaya. *Khlopchato-Bumazhnaya Prom.*, 1939, No. 6, P. 48–9; abs. in *C. A.*, 1940, V. 34, Col. 1487.

Expts. have shown that alginic acid can be used partly or completely as a substitute for gum and tragacanth in the prepn. of printing colors. The acid can also be used partly as a substitute for starch except in cases where a color of special density is desired. The characteristics of various colors prepd. with alginic acid are described. (C)

ALGINIC ACID AND ALGINATES. P. Colomb. *Teintex*, 1939, V. 4, P. 653–6; abs. in *C. A.*, 1940, V. 34, Col. 2183.

Alginic acid (I), found in large quantities in brown algae, is classified among the pectic compds. I has a configuration similar to that of cellulose and pectic acid. I is insol. in all ordinary solvents but its salts are sol. in H_2O, forming very viscous solns. The viscosity of the Na and Mg salts varies with pH, having a max. viscosity at pH 7. The Al and Zn alginates dissolve in NH_4OH, forming complexes. The Ag, Hg and Pb alginates are insol. Viscometric detns. of the mol. wt. of I indicate the presence of a glucoside chain and the methoxylic detns. can be used to det. the length of the chain. The alginates are used in sizing fibres and fabrics. Triethanolamine alginate aids the emulsification of linseed oil, cottonseed oil and paraffin. The pptn. of the insol. Al and Cu alginates on fibres can be used for waterproofing. (C)

ALUMINUM TRIFORMATE AS A WATERPROOFING AGENT. Marcel Burnand. *Teintex*, 1939, V. 4, P. 585–8; abs. in *C. A.*, 1940, V. 34, Col. 2183.

The prepn. and soly. of $(HCOO)_3Al$ at various temps. (20–70.6°) are reviewed and methods of applying it to fabrics discussed. (C)

THE APPLICATION OF NAPHTHOL DYES TO COTTON AND OTHER TEXTILES. Joseph Lindsay, Jr. *Cotton*. Part 1–2. 1939, November, P. 59–61; December, P. 67–68, 112.

Part 1 discusses the naptholating of the material, intermediate treatments, developing, aftertreatments and dragotizing of the bases. Part 2 deals with the chemical constitution of the naphthols, fast color salts, the pH of the developing bath, substantivity of naphthols, printing with naphthols, etc. (C)

ARTIFICIAL RESINS IN TEXTILES: DEPOSITION OF. Fritz Ohl. *Kunstseide u. Zellwolle*, 1940, V. 22, P. 32–4; abs. in *C. A.*, 1940, V. 34, Col. 2610.

Cellulose fibres were impregnated with a soln. of 100 g. urea, 50 g. phthalic acid and 110 cc. H_2O, dissolved hot, and cooled; then 250 cc. of CH_2O soln. and some sucrose were added to prevent premature sepn. of resin

with the subsequent pressure treatment. This resulted only in surface coating of the fibres, which was not very effective. Deposition of resin throughout the fibre was obtained by impregnating first with the urea-phthalic acid soln. and then adding the CH_2O during the pressure treatment. This treatment makes the fibres water- and wrinkle-proof and "animalizes" them with regard to their dyeing properties. (C)

IV. Research Methods and Apparatus

Fibres, Yarns and Fabrics: Testing. Interntl. Stand. Assoc. *Leipz. Monats. Text. Ind.*, 1939, V. 54, P. 159–60; abs. in *J. T. I.*, Oct. 1939, P. A656.

A report is given of the recommendations made at the meeting in March, 1939, of the sub-committee for the study of textile testing set up by the International Standards Association. The normal atmosphere for testing is $65 \pm 2\%$. RH and 20° C. (range 18–25° C.). Rules are given for length and count determinations on yarns. The standard tension is that equivalent to the weight of 100 metres of the yarn. (C)

Laboratory Detergency Tests. Frank A. Lucy. *Text. Wld.*, Oct. 1939, P. 76–8.

Test methods for determining efficiency of cleaning agents under various conditions. (C)

Testing the Stiffness of Yarns and Twines. Donald C. Scott. *Am. Dye. Rptr.*, Feb. 19, 1940, P. 77–80; *Text. Recdr.*, Jan. 6, 1940, P. 35–6.

For a yarn and twine stiffness test the author uses the circular loop as the simplest to work with. The loop is made by carefully tying the sample piece around a tapered wooden tube at the required diameter. The ends are fastened with a square knot and clipped as short as possible. The ring may then be slipped off the tapered tube and set in the tester. The tester consists essentially of a deflection measuring device, a needle point balance, and a calibrated coain which may be unwound from a dial thereby loading the loop with small increments of weight. Formulae based upon the elastic theory of the loop are given, as are those for stiffness number, % resilience, etc. Test results are also given of effect of sizing, of drying temperature, and of % regain on yarn stiffness. (C)

Textile Chemical Analysis. Bernhard Kneer. *Klepzig's Textil-Z.*, 1939, V. 42, P. 484–5; abs. in *C. A.*, 1940, V. 34, Col. 1179.

Methods are described for the detection of active O in peroxide bleaches and the detn. of fats in textiles by extn. with acetone. Ca soaps are not extd. by acetone; they are detd. by extn. with C_6H_6 or CCl_4. (C)

Wool Fibre: Contribution to the Histology and Pathology of. Horst Reumuth. *Klepzig's Textil-Z.*, 1939, V. 42, P. 352–60, 495–510, 538–41; abs. in *C. A.*, 1940, V. 34, Col. 1180.

The structure of wool and the damage to wool caused by acids, alkalies, H_2O_2, Cl and other chemicals, and by fungi and bacteria are reviewed. The Pauly reaction is suitable for damages that are not too large; it is unsuit-

able for damages in which all of the epidermis and subcutis have been destroyed. The following new method of prepg. pure stable diazobenzenesulfonic acid is given: To 50 g. of sulfanilic acid and aprox. 25 g. KOH in 250 cc. soln., cooled thoroughly, add 200 cc. of cold 10% $NaNO_2$ soln., and drop by drop an ice-cooled soln. contg. 80 cc. concd. HCl and 40 cc. of water. 55 references and 48 figures. (C)

WOOL-STAPLE FIBRE FABRICS: MEASURING FELTING POWER OF. *Rev. Text.*, 1939, V. 37, P. 257–62; abs. in *J. T. I.*, Dec. 1939, P. A777.

The findings of Nitschke on the influence of staple fibre on the felting property of wool are criticized. The strength of a felt made from a mixture of wool and other fibres does not provide a criterion of feltability. It is suggested that feltability should be measured on woven fabrics in terms of cover produced or by the time taken to mill to given dimensions. (C)

V. PURE SCIENCE, ECONOMICS AND MISC.

AGING AND MOLECULAR SIZE OF CHAIN COMPLEXES IN SOLUTION. W. Wehr. *Kolloid Z.*, Sept. 1939, V. 88, No. 3, P. 290–318; cf. *Ibid.*, Aug. 1939, V. 88, No. 2, P. 185–208; abs. in *Eastman Kodak Abs. Bull.*, Jan. 1940, P. 43. (S)

ARACHIS OIL: DETECTION OF—IN CRUDE AND RECTIFIED OIL FROM PRESSED OLIVES. A. Paleni and F. de'Lorenzi. *Annali Chim. Appl.*, 1939, V. 29, P. 253–71 (through Brit. C. A., B., 1939, V. 53, P. 1054); abs. in *J. T. I.*, Dec. 1939, P. A814.

Methods for the detection of arachis oil which depend on separation of solid fatty acids from 90% ethyl alcohol give positive results with (unadulterated) refined, residual oil from olives. This is due to the presence of fatty acids (isomerides of oleic acid) of melting point 40–50°. The tests are also vitiated by the presence of oxidized acids and unsaponifiable matter. Methods of isolating and examining the solid fatty acids from olive oils of various grades are described. (C)

CELL WALLS: SUB-MICROSCOPIC STRUCTURE. A. Frey-Wyssling. *Science Progress*, 1939, V. 34, P. 249–62; abs. in *J. T. I.*, Jan. 1940, P. A45.

A report of a lecture summarizing recent work by the author and other botanists on the properties of cell walls (especially their anisotropy), methods of microscopic and X-ray investigation, the micellar theory, and types of membrane structures and the growth of cell walls. (C)

CELLULOSE: MODIFICATION OF—BY OXIDATION. G. F. Davidson. *J. Soc. Dyers Col.*, Feb. 1940, P. 58–63.

A review of some of the recent work in this field. (C)